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Evolution of Magnetic Fields in Stars Across the Upper Main Sequence: I. A catalogue of magnetic field measurements with FORS 1 at the VLT*

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Abstract. To properly understand the physics of Ap and Bp stars it is particularly important to identify the origin of their magnetic fields. For that, an accurate knowledge of the evolutionary state of stars that have a measured magnetic field is an important diagnostic. Previous results based on a small and possibly biased sample suggest that the distribution of magnetic stars with mass below $3\,M_{\odot}$ in the H-R diagram differs from that of normal stars in the same mass range (Hubrig et al. 2000). In contrast, higher mass magnetic Bp stars may well occupy the whole main-sequence width (Hubrig, Schöller & North 2005b). In order to rediscuss the evolutionary state of upper main sequence magnetic stars, we define a larger and bias-free sample of Ap and Bp stars with accurate Hipparcos parallaxes and reliably determined longitudinal magnetic fields. We used FORS 1 at the VLT in its spectropolarimetric mode to measure the magnetic field in chemically peculiar stars where it was unknown or poorly known as yet. In this first paper we present our results of the mean longitudinal magnetic field measurements in 136 stars. Our sample consists of 105 Ap and Bp stars, two PGa stars, 17 HgMn stars, three normal stars, and nine SPB stars. A magnetic field was for the first time detected in 57 Ap and Bp stars, in four HgMn stars, one PGa star, one normal B-type star and four SPB stars.

Key words: stars:chemically peculiar - stars:evolution - stars:magnetic fields

1. Introduction

Ap and Bp stars are main-sequence A and B stars in the spectra of which the lines of some elements are abnormally strong (e.g., Si, Sr, rare earths) or weak (in particular, He). They undergo periodic variations of magnitude (in various photometric bands) and spectral line equivalent widths; the known periods of variability range from half a day to several decades. Among Ap stars, the magnetic chemically peculiar stars are especially important. For a long time, Ap stars were the only non-degenerate stars besides the sun in which direct detections of magnetic fields had been achieved. Today, they still represent a major fraction of the known magnetic stars. These stars generally have large-scale organized magnetic fields that can be diagnosed through observations of circular polarization in spectral lines. The unique large-scale organization of the magnetic fields in these stars, which in many cases appears to occur essentially under the form of a single large dipole located close to the centre of the star, contrasts with the magnetic field of late-type stars, which is most probably subdivided in a large number of small dipolar elements scattered across the stellar surface. The fact that magnetic fields of Ap stars are more readily observable than those of any other type of non-degenerate stars makes them a privileged laboratory for the study of phenomena related to stellar magnetism.

To properly understand the physics of Ap stars it is particularly important to know the origin of magnetic fields in these stars. It is the subject of a long debate, which is far from being closed (e.g., Braithwaite & Spruit 2004). After the discovery of magnetic fields in Ap and Bp stars it was proposed that these stars have acquired their field at the time of their formation or early in their evolution (what is currently observed is then a fossil field). An alternative suggestion is that magnetic fields are generated and maintained by a contemporary

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dynamo at work inside the star. Whether the A and B stars become magnetic at a certain evolutionary state before reaching the zero-age main sequence (ZAMS), or during the core hydrogen burning, or at the end of their main-sequence life requires systematical studies of established cluster members, binary systems, and field stars with accurate Hipparcos parallaxes. Until now, there is only one case of a strongly magnetic Ap star of mass below 3 $M_{\odot}$ (either member of a nearby moving cluster or supercluster or belonging to a binary system) which is not much evolved away from the ZAMS: HD 66318 in NGC 2516 is claimed to have fulfilled only 16% of its main sequence lifetime (Bagnulo et al. 2003; see also Hubrig & Schwan 1991; Hubrig & Mathys 1994; Wade et al. 1996). Only a few double-lined spectroscopic binary systems containing a magnetic Ap star are currently known, and as far as the membership of Ap stars in distant open clusters is concerned, we should keep in mind that such studies are mostly based upon photometry and upon radial velocity determinations. But photometric criteria of cluster membership are more delicate to apply to peculiar stars, since strong backwarming effects lead to an anomalous energy distribution, thus affecting the position of such stars in colour-magnitude diagrams.

In our previous study of the evolutionary state of magnetic Ap stars with accurate Hipparcos parallaxes and accurate measurements of the mean magnetic field modulus and mean quadratic magnetic fields, we showed that the distribution of magnetic stars of mass below 3 $M_{\odot}$ differs from that of normal stars in the same temperature range at a high level of significance (Hubrig, North & Mathys 2000). Normal A stars occupy the whole width of the main sequence, without a gap, whereas magnetic stars are concentrated towards the centre of the main-sequence band. In particular, it was found that magnetic fields appear in stars that have already completed at least approximately 30% of their main-sequence lifetime.

Knowing the position of the magnetic stars in the H-R diagram, it became also possible to probe the evolution of magnetic field strength across the main sequence. However, no clear picture emerged from our data. Yet, the whole sample under study contained only 33 magnetic stars of mass below 3 $M_{\odot}$. We exclusively selected stars for which a strong surface magnetic field had been definitely detected. For these stars the mean magnetic field modulus, which is the average over the stellar disk of the modulus of the magnetic vector, has been derived through measuring the wavelength separation of resolved magnetically split components of spectral lines. The mean quadratic field has been diagnosed from the consideration of the differential magnetic broadening of spectral lines. A bias was present due to the fact that our sample contained a large fraction (about 2/3) of stars with rotational periods longer than 10 days, while the majority of the periods of magnetic stars fall between 2 and 4 days. Clearly, there was a need for more magnetic field measurements of Ap stars for which accurate Hipparcos parallaxes were obtained. To this purpose, we started a few years ago a long-term systematical search for magnetic fields in about 100 upper main sequence chemically peculiar stars with good Hipparcos parallaxes. These stars were chosen in a wider range of masses, among those whose magnetic field has been never or only poorly studied before, and presenting a distribution of rotational periods more representative of that of all Ap and Bp stars.

In this first paper, we present results of magnetic field measurements in 136 A and B stars. The detailed analysis of the evolution of the magnetic field across the H-R diagram in stars of different mass will be presented in a second paper. Some preliminary results of the analysis based on the magnetic field measurements from the first release of data for our ESO observing program have already been reported at various meetings (Hubrig, Schöller & North 2005b; Hubrig, North & Szeifert 2006). In general, we could confirm our previous results obtained from the study of Ap and Bp stars with accurate measurements of the mean magnetic field modulus and mean quadratic magnetic fields, i.e., that magnetic stars of mass below 3 $M_{\odot}$ are concentrated towards the centre of the main-sequence band. We could also show that, in contrast, higher mass magnetic Bp stars may well occupy the whole main-sequence width.

2. Basic data

The General Catalogue of Ap and Am stars (Renson, Gerbaldi & Catalano 1991) includes 2875 Ap stars showing abnormal enhancement of one or several elements in their atmosphere. Hipparcos parallaxes have been measured for about 940 Ap stars. 371 of them have a low parallax error of $\sigma(\pi)/\pi < 0.2$ (Gomez et al. 1998).

Most studies of magnetic fields of Ap stars are based on measurements of the mean longitudinal magnetic field, which is an average over the visible stellar hemisphere of the component of the magnetic vector along the line of sight. It is derived from measurements of wavelength shifts of spectral lines between right and left circular polarization. Before our study, only 195 Ap stars had reliably measured longitudinal fields, ranging from tens of Gauss to about 20 kG (Bychkov, Bychkova & Madej 2003). But only for 114 stars with measured magnetic fields the parallax error was less than 20%. A part of these stars have been used for our study of the evolutionary state of magnetic stars six years ago.

For 49 stars the mean magnetic field modulus has been derived from measurements of the wavelength separation of resolved magnetically split components of spectral lines. The resolution of individual line components requires a combination of sufficient magnetic field strength and small enough projected rotational velocity. The mean field modulus is, by definition, much less aspect-dependent than the longitudinal field and, thus, it characterizes much better the intrinsic stellar magnetic field. Unfortunately, it can only be measured in a small fraction of Ap stars that have magnetically resolved lines. Therefore, longitudinal field measurements represent the standard method for searching magnetic fields in different types of stars, and longitudinal field measurements, due to their sensitivity to aspect, represent essential constraints for all models of the geometry and the detailed structure of the magnetic fields of these stars. This underscores the important

role of these data in understanding magnetism in upper-main sequence stars.

As Bagnulo et al. (2002) and Hubrig et al. (2004) have demonstrated, low resolution spectropolarimetry in H Balmer lines obtained with FORS 1 represents a powerful diagnostic method for the detection of stellar magnetic fields. FORS 1 is a multi-mode instrument which is equipped with polarization analyzing optics comprising super-achromatic half-wave and quarter-wave phase retarder plates, and a Wollaston prism with a beam divergence of 22″ in standard resolution mode. In our latest study of magnetic fields in rapidly oscillating Ap stars with FORS 1 in spectropolarimetric mode, using GRISM 600B and an 0.″4 slit, a formal uncertainty as small as 50 G has been achieved, suggesting that the potential of FORS 1 for measuring magnetic fields is even higher than indicated before (Hubrig et al. 2004). For the major part of our stellar sample we used the GRISM 600B in the wavelength range 3480–5890 Å at a spectral resolution of R$\sim$2000 to cover all hydrogen Balmer lines from H_β to the Balmer jump. During the last semester in 2005 we used the GRISM 1200g to cover the H Balmer lines from H_β to H_8, and the narrowest available slit width of 0.″4 to obtain a spectral resolving power of R$\sim$4000. The determination of the mean longitudinal fields using FORS 1 is described in detail in Hubrig et al. (2004). All longitudinal field determinations for the 136 stars in our sample were obtained from observations with FORS 1 at the VLT executed in service mode from April 2003 to September 2005.

In order to be able to determine the location of the observed stars in the H-R diagram, we selected only stars for which distance and photometry can be obtained with small error bars. 127 out of 136 stars in our sample have accurately determined Hipparcos parallaxes with $\sigma(\pi)/\pi < 0.2$. For all objects, there exists either Geneva or Strömgren photometry.

Nine stars in our sample are known members of nearby open clusters of different ages and have very accurate Hipparcos parallaxes. Their membership has been confirmed on photometric, proper motion and radial velocity grounds. They are excellent candidates for our study and the measurements of their magnetic fields allow us to put more stringent constraints on the origin of the magnetic fields.

Magnetic fields play an important role in the theoretical interpretation of the pulsations in rapidly oscillating Ap (roAp) stars. However, until now, the only systematic attempt to detect and to study their field has been done by Mathys (2003). Still, the knowledge of the magnetic fields in many roAp stars is very incomplete. Therefore, a few roAp stars, for which no magnetic field measurements have been reported before, have been included in our sample.

The presence of magnetic fields in so-called "non-magnetic" stars with HgMn or PGa peculiarity is still a subject of debate between various observers. To understand the role that magnetic fields play for the origin of chemical peculiarities in these stars, magnetic field measurement have been carried out for 17 HgMn and two PGa stars.

Recently, Neiner et al. (2003) presented the first detection of a magnetic field in the SPB star ζ Cas. It is difficult to explain why chemically peculiar hot Bp stars and Slowly Pulsating B (SPB) stars co-exist at the same position in the H-R diagram, namely in the SPB instability strip. The pulsation periods of SPB stars range from about 1 to 3 days. It is especially intriguing that the magnetic fields of hot Bp stars do not show any detectable variations or vary with periods close to 1 day. A small sample of SPB stars and a few monoperiodic B stars with a non-homogeneous distribution of chemical elements on the stellar surface has been selected to search for an evidence of magnetic fields.

3. Results

193 new mean longitudinal magnetic field measurements for Ap, Bp stars and so-called "non-magnetic" stars are presented in Tables A1 and A2, respectively. In the first two columns we give the HD number and another identifier. The V magnitude and the spectral type are retrieved from the "General Catalogue of Ap and Am stars" by Renson et al. (1991) and in part from the SIMBAD database in case the studied stars had no entry in the catalogue. The modified Julian date of the middle of the exposures and the measured mean longitudinal magnetic field $\langle B_\mathrm{l} \rangle$ are presented in columns 5 and 6. If there are several measurements for a single star, we give the reduced χ^2 for these measurements in column 7, following:

$$\chi^2/n = \frac{1}{n} \sum_{i=1}^{n} \left(\frac{\langle B_l \rangle_i}{\sigma_i} \right)^2 \tag{1}$$

Finally, in column 8 we identify new detections by ND and confirmed detections by CD. We would like to point out that all claimed detections have a significance of at least 3 σ, determined from the formal uncertainties we derive. In individual cases a 3 σ detection could be caused by a statistical outlier in our rather large sample of individual stars, or by slightly underestimated errors.

Because of the strong dependence of the longitudinal field on the rotational aspect, its usefulness to characterise actual field strength distributions is limited, but this can be overcome, at least in part, by repeated observations to sample various rotational phases, hence various aspects of the field. Three observations per star should be the strict minimum to give a meaningful estimate of the intrinsic strength of the magnetic field of a star. This estimate consists in the rms longitudinal field, which is computed from all n measurements according to:

$$\overline{\langle B_l \rangle} = \left(\frac{1}{n} \sum_{i=1}^{n} \langle B_l \rangle_i^2 \right)^{1/2} \tag{2}$$

While we asked for three observations per star, unfortunately, quite a number of stars of our program could be observed only once or twice. In the course of our systematical search for magnetic fields in 136 upper main sequence chemically peculiar stars with good Hipparcos parallaxes and in a wider range of mass, we discovered 67 new magnetic stars. For five other stars we could confirm earlier detections listed in the catalogue by Bychkov, Bychkova & Madej (2003). In 15 stars we confirmed our own detections a second or third time. In Fig. 1 we present V/I spectra in the vicinity

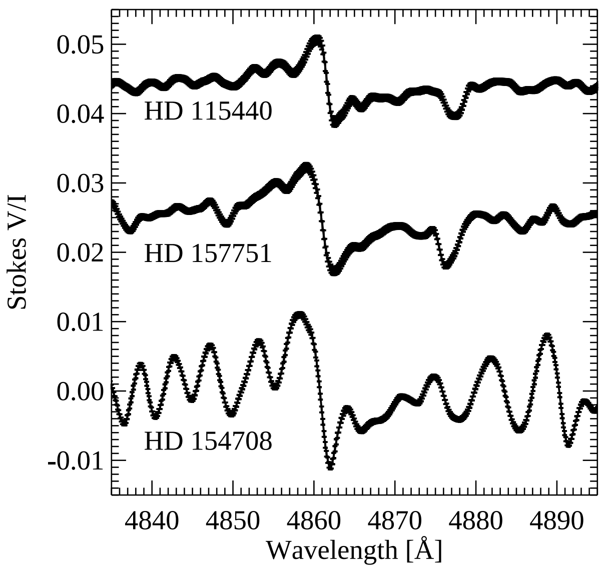

Fig. 1. V/I spectra of the newly discovered magnetic stars HD 115440, HD 157751, and HD 154708 in the vicinity of the H_β line.

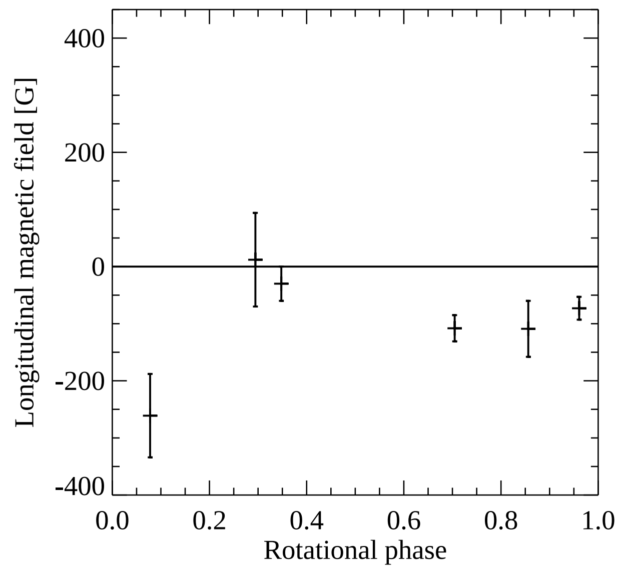

Fig. 2. Longitudinal magnetic field measurements in α And as a function of rotational phase.

of the H_β line in one of the most massive stars in our sample, HD 115440, one star of intermediate mass, HD 157751, and in the low mass star HD 154708.

In the sample of Ap and Bp stars (Table A1), six roAp stars show magnetic fields well above the 3 σ level, strongly underlying the close observational connection between magnetic field and pulsation: HD 42659, HD 60435, HD 80316, HD 84041, HD 86181 and HD 154708. The star HD 154708 is likely one of the coolest and least massive among the Ap stars and exhibits the second-largest mean magnetic field modulus, 24.5 kG, ever measured in an Ap star (Hubrig et al. 2005a). Low-amplitude pulsations in HD 154708 have recently been discovered by Kurtz et al. (2006, in preparation).

Among the 17 HgMn stars, weak magnetic fields have been detected in four stars, HD 358 (= HR15, α And), HD 65949, HD 65950, and HD 175640. Longitudinal magnetic field measurements in α And as a function of rotational phase are presented in Fig. 2. The phases have been calculated according to the rotational ephemeris of Adelman et al. (2002). We also detected a magnetic field at $>3\,\sigma$ level in one PGa star, HD 19400, and in the normal B-type star HD 179761. Five years ago we already showed evidence for a relative magnetic intensification of Fe II lines produced by different magnetic desaturations induced by different Zeeman-split components in HD 179761 (Hubrig & Castelli 2001). As the relative intensification is roughly correlated with the strength of the magnetic field, it is a powerful tool for detecting magnetic fields which have a complex structure and are difficult to detect by polarization measurements.

Weak magnetic fields have also been discovered in four SPB stars: HD 53921, HD 74560, HD 85953, and HD 215573. There have been only a few isolated attempts to determine magnetic fields in SPB stars. Neiner et al. (2003) searched for a magnetic field in the B2IV star ζ Cas, which lies in the region of the H-R diagram that belongs both to the SPB and the β Cep instability strip. Using time-resolved spectropolarimetric observations with the Musicos echelle spectropolarimeter at the 2 m Telescope Bernard Lyot they obtained clear Zeeman signatures indicative of the presence of a magnetic field over the rotational period of 5.4 d. This star was the first known magnetic SPB star. However, the role that magnetic fields play in the understanding of pulsational properties of SPB stars is still unclear, and further observations are needed to look for possible relations between magnetic field and pulsation patterns.

Normal B, HgMn, PGa, and SPB stars are usually regarded as non-magnetic stars. However, the intriguing discovery of mean longitudinal magnetic fields of the order of a few hundred Gauss in a sample of so-called “non-magnetic” stars rises a fundamental question about the possible ubiquitous presence of a magnetic field in upper main sequence stars. The structure of the field in these stars must be, however, sufficiently tangled so that it does not produce a strong net observable circular polarization signature.

In this paper, we presented results of our comprehensive study of magnetic fields in 136 upper main sequence stars. The magnetic field determination method is based on circular polarized FORS 1 spectra and shows the excellent potential of FORS 1 for measuring magnetic fields. The preliminary results of our analysis of the evolutionary state of magnetic chemically peculiar stars based on the smaller sample of stars measured with FORS 1 have been presented in the last years as meeting contributions (Hubrig et al. 2005b; Hubrig et al. 2006). In Paper II we will present the complete analysis based on a large sample of magnetic stars.

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Appendix A: List of magnetic field measurements

Table A1. The mean longitudinal field measurements for our sample of Ap and Bp stars observed with FORS 1 in the frame of our ESO service programs 71.D-0308, 072.D-0377, 073.D-0464, and 075.D-0295. In the first two columns we give the HD number and another identifier. The V magnitude and the spectral type are retrieved from the "General Catalogue of Ap and Am stars" by Renson et al. (1991) and in part from the SIMBAD database in case the studied stars had no entry in the catalogue. The modified Julian date of the middle of the exposures and the measured mean longitudinal magnetic field $\langle B_l \rangle$ are presented in columns 5 and 6. If there are several measurements for a single star, we give the reduced χ^2 for all measurements in column 7. Finally, in column 8 we identify new detections by ND and confirmed detections by CD (see text).

HD	Other identifier	V	Sp. Type	MJD	$\langle B_l \rangle$ [G]	χ^2/n	Comment
1048	HR49	6.2	A1 Si	52910.103	244± 74		ND
				53199.406	−69± 54		
				53215.382	84± 53		
				53216.405	56± 45	4.1	
3326	HR151	6.1	A6 Sr	52908.190	49± 49		
3980	HR183	5.7	A7 Sr Eu Cr	53559.410	1210± 32		CD
				53624.076	395± 26		CD
				53630.232	452± 15	856.2	CD
8783	CP−72 98	7.8	A2 Sr Eu Cr	52852.358	26± 92		
10840	CP−61 139	6.8	B9 Si	53184.331	−161±131		
19712	BD−02 563	7.3	A0 Cr Eu	52905.384	−963± 77		ND
				52999.025	550± 42	163.9	CD
19918	CP−82 54	9.4	A5 Sr Eu Cr	52908.210	−625± 87		CD
22374	BD+22 518	6.7	A1 Cr Sr Si	52999.039	31± 57		
				53216.383	−72± 59	0.9	
22488	CP−67 236	7.7	A3 Sr Eu Cr	53087.014	102± 53		
23207	BD−19 732	7.5	A2 Sr Eu	53215.361	259± 92		
				53218.338	411± 94	13.5	ND
24188	CP−72 262	6.3	A0 Si	53087.032	404± 55		ND
30612	HR1541	5.5	B9 Si	53087.046	10± 51		
34797	HR1754	6.5	B8 He-weak Si	52999.066	713± 54		ND
34798	HR1753	6.5	B8 He-weak Si	52999.055	56± 82		
42659	BD−15 1299	6.7	A3 Sr Cr Eu	52999.119	392± 72		ND
55522	HR2718	5.9	B2IV/V	52999.190	38± 73		
				52999.227	39±234		
				53000.053	873± 66	58.4	ND
56350	CP−53 1284	6.7	A0 Eu Cr Sr	52999.239	736±125		ND
56455	HR2761	5.7	A0 Si	52999.251	−119± 70		
58448	CP−61 814	7.1	B8 Si	52999.265	−331± 66		ND
60435	CP−57 1246	8.9	A3 Sr Eu	53000.072	−296± 52		ND
63401	HR3032	6.3	B9 Si	53002.053	−236± 70		ND
				53004.228	−656± 75	43.9	CD
68826	CO−48 3586	9.3	B9 Si	53454.077	80± 64		
69144	HR3244	5.1	B2.5IV	52989.350	41± 63		
74168	CO−51 3141	7.5	B9 Si	53002.111	−437±101		ND
74196	HR3448	5.6	B7 He-weak	52906.388	254±118		
75989	CO−40 4685	6.5	B9 Si	52992.341	−368±107		ND
				53004.286	−409±105	13.5	CD
80316	BD−19 2674	7.8	A3 Sr Eu	52992.357	−183± 38		ND
83625	CP−53 2664	6.9	A0 Si Sr	53008.325	−1208± 64		ND
84041	CO−28 7536A	9.4	A5 Sr Eu	53002.170	479± 72		ND
86181	CP−58 1700	9.4	F0 Sr	53002.201	404± 94		ND
86199	CP−56 2646	6.7	B9 Si	53003.345	−921± 67		ND
88158	CP−61 1479	6.5	B8 Si	53008.338	−8± 75		
88385	CP−56 2919	8.1	A0 Cr Eu Si	53010.181	−1054± 65		ND
89103	CO−48 5469	7.8	B9 Si	53010.202	−2303± 48		ND
89385	CP−53 3579	8.4	B9 Cr Eu Si	53010.218	−255± 61		ND
90264	HR4089	5.0	B8 He-weak	52824.019	114±108		
91239	CO−41 5923	7.4	B9 Eu Cr Si	53118.059	−33± 89		
92106	CP−80 468	7.8	A0 Sr Eu Cr	53010.239	−258± 71		ND
				53118.080	−243±102	9.4	
92385	CP−64 1374	6.7	B9 Si	53008.369	−623±100		ND
				53020.332	−165± 59	23.3	

Table A1. Continued.

HD	Other identifier	V	Sp. Type	MJD	$\langle B_l \rangle$ [G]	χ^2/n	Comment
92499	CO−42 6407	8.9	A2 Sr Eu Cr	53010.255	−964±172		ND
				53011.212	−1255± 69		CD
				53118.095	−1191±148	142.3	CD
93030	HR4199	2.7	B0 Si N P	53012.231	−205±137		
96451	CP−74 771	6.9	A0 Sr	53074.346	108± 70		
98340	CP−58 3433	7.1	B9 Si	53074.362	977± 73		ND
99563	BD−08 3173A	8.5	F0 Sr	53012.247	−235± 73		CD
				53015.225	−670± 84	37.0	CD
105379	CO−30 9691	8.0	A0 Sr Cr	53011.250	−283± 74		ND
105382	HR4618	4.4	B6IIIe	53011.195	−923± 86		ND
				53015.247	−431±109	65.4	CD
105770	CP−83 444	7.4	B9 Si	53011.233	160± 58		
				53120.145	254± 83	8.5	ND
105999	CP−62 2619	7.4	F1 Sr Cr	53011.270	−247± 58		ND
107696	HR4706	5.4	B8 Cr	52824.030	−9± 90		
				53074.375	−134±145	0.4	
108945	HR4766	5.5	A3 Sr	53015.335	−347± 51		ND
114365	HR4965	6.1	A0 Si	52824.043	−24± 57		
115226	CP−72 1373	8.5	A3 Sr	53074.392	820±139		ND
				53086.299	654± 66	66.5	CD
115440	CP−75 859	8.2	B9 Si	53077.215	3120± 73		ND
116890	HR5066	6.2	B9 Si	52824.055	−119± 62		
117025	HR5069	6.1	A2 Sr Eu Cr	52824.067	455± 73		ND
				53120.164	416± 94	29.2	CD
118913	CP−68 1981	7.7	A0 Eu Cr Sr	52824.081	−385± 71		ND
				53120.181	−544± 75	41.0	CD
119308	CO−34 9094	7.8	B9 Sr Cr Eu	53120.204	−325± 73		ND
122970	BD+06 2827	8.3	F0p	53015.350	352±101		CD
125630	CP−66 2519	6.8	A2 Si Cr Sr	52824.107	659± 54		ND
				53120.221	9± 63	74.5	
127453	CP−68 2132	7.4	B8 Si	52824.121	−360± 69		ND
127575	CP−68 2135	7.7	B9 Si	53079.388	807± 72		ND
128775	CO−45 9337	6.6	B9 Si	53120.236	−340± 61		ND
128974	HR5466	5.7	A0 Si	52824.144	40± 45		
129899	CP−76 894	6.4	A0 Si	53120.295	402± 48		ND
130158	HR5514	5.6	B9 Si	52824.176	28± 44		
				53116.312	51± 43	0.9	
130557	HR5522	6.1	B9 Si Cr	52853.058	−30± 74		
				53144.267	100± 50	2.1	
131120	HR5543	5.0	B7 He-weak	52824.158	−228±110		
				53020.353	−137± 74		
				53030.366	63± 69	2.9	
132322	CP−63 3473	7.4	A7 Sr Cr Eu	53111.311	357± 51		ND
133792	HR5623	6.3	A0 Sr Cr	52853.070	−55±116		
				53120.312	68± 47	1.2	
134305	BD+13 2899	7.2	A6 Sr Eu Cr	53144.301	117± 68		
136933	HR5719	5.4	A0 Si	52823.223	56± 68		
138758	CP−74 1451	7.9	B9 Si	53086.328	415± 47		ND
138764	HR5780	5.2	B6 Si	52904.016	146± 57		
138769	HR5781	4.5	B3IVp	52904.027	−16± 58		
				52908.022	−260± 84	4.8	ND
145102	CO−2611240	6.6	B9 Si	52763.315	−48± 75		

Table A1. Continued.

HD	Other identifier	V	Sp. Type	MJD	$\langle B_l \rangle$ [G]	χ^2/n	Comment
147869	HR6111	5.8	A1 Sr	52763.327	28± 62		
				53144.318	−68± 47	1.1	
148112	HR6117	4.6	A0 Cr Eu	52763.338	−62± 53		
148898	HR6153	4.4	A6 Sr Cr Eu	52763.349	175± 70		
149764	CO−3811087	6.9	A0 Si	52763.374	−1213± 70		ND
				53120.325	20± 68		
				53120.335	30± 57	100.2	
149822	HR6176	6.4	B9 Si Cr	52763.361	−645± 54		ND
150549	HR6204	5.1	A0 Si	52763.386	−187± 51		ND
				53116.386	−228± 59		CD
				53120.350	−110± 52	11.0	
151525	HR6234	5.2	B9 Eu Cr	52733.395	−14± 60		
				52763.397	186± 61	4.7	CD
154708	CP−57 8336	8.8	A2 Sr Eu Cr	53120.376	7530± 54		ND
				53487.302	5764± 25		CD
				53519.344	5819± 52	28375.0	CD
157751	CO−3312069	7.6	B9 Si Cr	52793.271	4063± 54		ND
				53116.404	3968± 55	5433.1	CD
160468	CP−68 2936	7.3	F2 Sr Cr	53116.362	63± 63		
				53134.319	−205±101	2.6	
161277	CO−3911816	7.1	B9 Si	53134.339	1± 42		
166469	HR6802	6.5	A0 Si Cr Sr	52793.287	−15± 55		
				52793.295	−133± 60		
				53136.274	−42± 52	1.9	
168856	BD−07 4589	7.0	B9 Si	53144.343	−608± 47		ND
171184	BD−14 5110	8.0	A0 Si	52880.042	379± 58		ND
				53144.368	−54± 48	22.0	
171279	BD−07 4623	7.3	A0 Sr Cr Eu	53144.393	−45± 46		
172032	BD−16 4963	7.7	A9 Sr Cr	53151.105	−8± 67		
172690	CP−84 587	7.5	A0 Si Sr Cr	52793.314	−225± 71		ND
				53134.368	230± 60	12.4	CD
175744	HR7147	6.6	B9 Si	52901.019	147± 53		
176196	CP−74 1739	7.5	B9 Eu Cr	52793.329	258± 69		ND
				53134.389	174± 58	11.5	CD
183806	HR7416	5.6	A0 Cr Eu Sr	52793.345	−229± 45		ND
				53120.424	172± 43	20.9	CD
186117	CP−73 2061	7.3	A0 Sr Cr Eu	53134.413	−52± 55		
				53140.329	−36± 54	0.7	
192674	CO−5112473	7.5	B9 Cr Eu Sr	53137.362	−30± 45		
199180	BD+16 4401	7.7	A0 Si Cr	52822.344	−215± 74		
199728	HR8033	6.2	B9 Si	52822.357	−254± 60		ND
201018	CO−3714125	8.6	A2 Cr Eu	53151.371	494±153		ND
202627	HR8135	4.7	A1 Si	52793.374	−118± 57		
206653	CP−68 3444	7.2	B9 Si	52793.394	125± 83		
212385	CO−3914697	6.8	A3 Sr Eu Cr	52822.413	145± 59		
				53184.297	541± 60	43.7	ND
221760	HR8949	4.7	A2 Sr Cr Eu	52793.415	−103± 80		
				53184.314	16± 85	0.8	
223640	HR9031	5.2	B9 Si Sr Cr	52822.428	−74± 51		

Table A2. The mean longitudinal field measurements for our sample of so-called "non-magnetic" stars observed with FORS 1 in the frame of our ESO service programs 71.D-0308, 072.D-0377, 073.D-0464, and 075.D-0295. In the first two columns we give the HD number and another identifier. The V magnitude and the spectral type are retrieved from the "General Catalogue of Ap and Am stars" by Renson et al. (1991) and in part from the SIMBAD database in case the studied stars had no entry in the catalogue. The modified Julian date of the middle of the exposures and the measured mean longitudinal magnetic field $\langle B_l \rangle$ are presented in columns 5 and 6. If there are several measurements for a single star, we give the reduced χ^2 for all measurements in column 7. In column 8 we identify new detections by ND and confirmed detections by CD (see text).

HD	Other identifier	V	Sp. Type	MJD	$\langle B_l \rangle$ [G]	χ^2/n	Comment
			HgMn stars				
358	HR15	2.1	B9 Mn Hg	52910.092	-261 ± 73		ND
				52963.020	12 ± 82		
				53519.448	-109 ± 49		
				53629.286	-73 ± 20		CD
				53630.208	-30 ± 30		
				53638.205	-108 ± 23	9.0	CD
23408	HR1149	3.9	B7 He-weak Mn	52963.156	-83 ± 46		
23950	HR1185	6.1	B9 Mn Hg Si	53215.403	62 ± 79		
				53216.418	50 ± 55	0.7	
49606	HR2519	5.8	B8 Mn Hg Si	52946.354	-11 ± 71		
53929	HR2676	6.1	B9 Mn Hg	52992.306	-178 ± 129		
				53004.210	-248 ± 108	3.6	
63975	HR3059	5.1	B8 Mn Hg	52992.278	95 ± 74		
65949	CP$-$60 966	8.4	B9 Hg	53002.082	-290 ± 62		ND
65950	CP$-$60 967	6.9	B9 Mn Hg	53002.067	-179 ± 53		ND
71066	HR3302	5.6	A0 Si Mn	53002.098	1 ± 56		
87752	CP$-$59 1843	9.8	B9 Hg Mn	53008.304	-151 ± 100		
155379	HR6386	6.5	A0 Hg Y	52763.410	46 ± 52		
				53137.393	-65 ± 46	1.4	
175640	HR7143	6.2	A0 Hg Mn Y	52901.043	207 ± 65		ND
186122	HR7493	6.3	B9 Mn Hg	52822.312	215 ± 76		
194783	HR7817	6.1	B9 Hg Mn	52793.361	-43 ± 53		
202149	HR8118	6.7	B9 Hg	53137.413	43 ± 39		
202671	HR8137	5.4	B7 He-weak Mn	53151.411	-109 ± 57		
221507	HR8937	4.4	B9 Mn Hg	52900.092	-61 ± 36		
			SPB stars				
24587	HR1213	4.6	B6	52971.071	-120 ± 68		
26326	HR1288	5.4	B5IV	52909.389	119 ± 80		
53921	HR2674	5.6	B9IV	52999.137	-294 ± 63		ND
74195	HR3447	3.6	B3IV	53002.123	-277 ± 108		
74560	HR3467	4.8	B3 Mg Si	53002.141	-199 ± 61		ND
85953	HR3924	5.9	B2III	53002.152	-131 ± 42		ND
92287	HR4173	5.9	B3IV	53008.352	-10 ± 57		
123515	HR5296	6.0	B8 Si	52824.093	-59 ± 50		
215573	HR8663	5.3	B6IV	52900.080	165 ± 53		ND
			PGa stars				
19400	HR939	5.5	B8 He-weak	52852.371	217 ± 65		ND
120709	HR5210	4.6	B5 He-weak P	53015.323	79 ± 76		
			Normal B stars				
91375	HR4138	4.7	A2	53116.028	-58 ± 56		
179761	HR7287	5.1	B8	52822.280	-267 ± 68		ND
209459	HR8404	5.8	B9	52822.381	-144 ± 60		